FOREWORD BY JENA PINCOTT
AUTHOR OF DO GENTLEMEN REALLY PREFER BLONDES?

BRAIN CHANGER

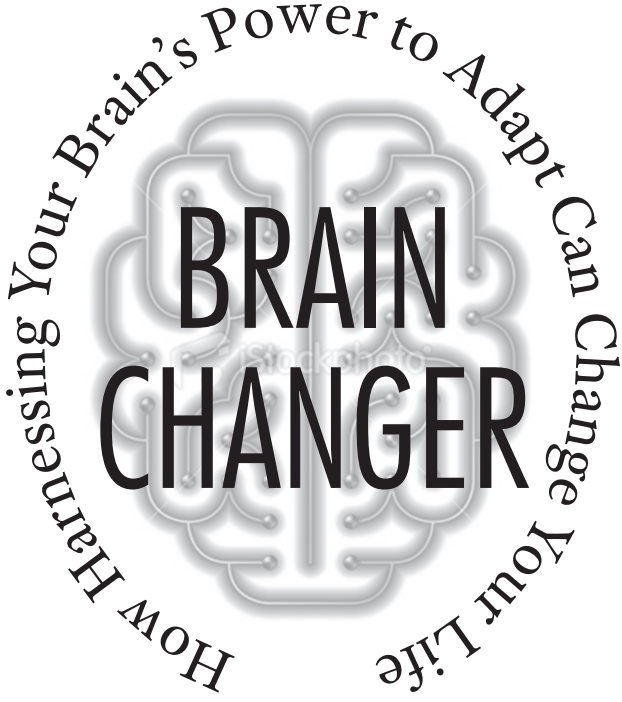
HOW HARNESSING YOUR BRAIN'S POWER TO ADAPT CAN CHANGE YOUR LIFE

DAVID DISALVO
AUTHOR OF WHAT MAKES YOUR BRAIN HAPPY AND WHY YOU SHOULD DO THE OPPOSITE

AUTHOR OF

What Makes Your Brain Happy and Why You Should Do the Opposite

and The Brain in Your Kitchen



DAVID DISALVO

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METACOGNITION

THE IMPASSIVE WATCHER IN THE TOWER

The ultimate value of life depends upon awareness and the power of contemplation rather than upon mere survival.

—*Aristotle*

We begin our discussion with a graphic, one that we'll revisit throughout the book as a sort of visual anchor for the concepts central to metacognition, adaptation, and major looping highways in between. The first stop is at the top: *defining metacognition itself*.

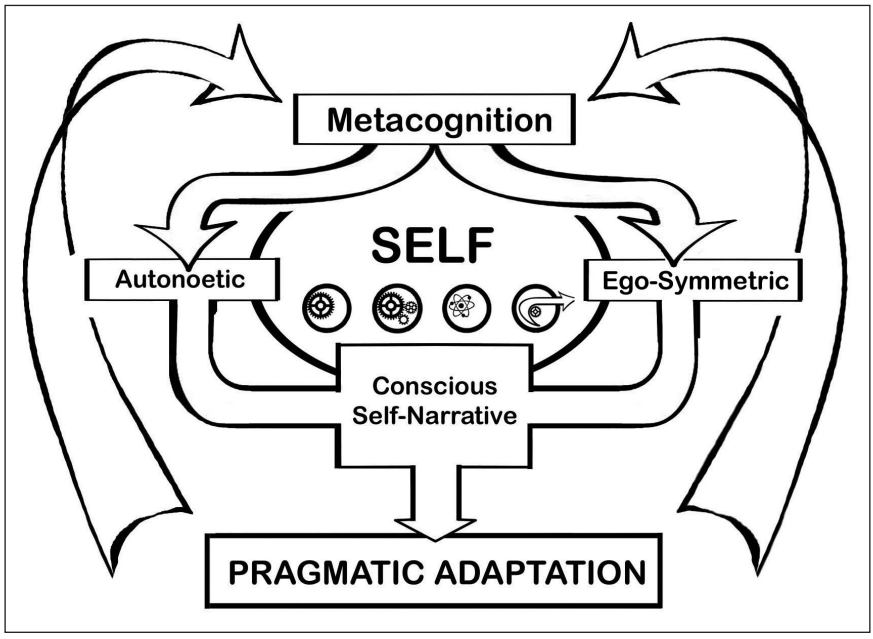
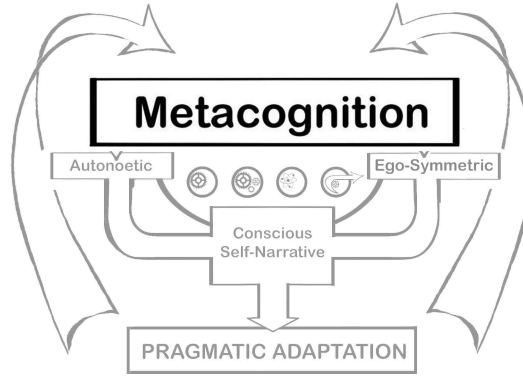


FIGURE 1.1

What Is Metacognition?



Problem-solving techniques—like those used in a variety of cognitive and behavioral therapies, for example—rely on a tool unique to humans, one that we use all the time (albeit intuitively, without strategy and typically without precision) whether we realize it or not. What this tool does, in a word, is facilitate *detachment* from a problem. It allows us to step away and apart from whatever is vexing us, and by doing so to gain perspective that wouldn't be possible to attain in the direct path of the problem[1].

The tool is metacognition, our ability to think about our thinking. We are not all on equal footing when it comes to using this tool effectively. Acquiring skill requires mental training; an inborn ability does not produce mastery. Once mastered, however, there is no more powerful internal tool available to us to solve problems, tackle challenges, and navigate paths to reach our goals.

Any time we reflect upon our thinking processes and knowledge, we are metacognizing[2]. Indeed, most of us do this all day long, though the way we do so generally lacks direction and tends to swerve into fields of endless rumination. To get the most from metacognition, we have to train ourselves to focus its power and forge the discipline necessary to stay focused despite distractions. This is a challenge, but meeting the challenge yields tangible results.

To put a finer point on all of this: metacognition is our most powerful internal tool to adjust our thinking and improve thinking outcomes.

Some of the ways this is accomplished—which we'll discuss throughout the book—include:

- Influencing feedback loops, the engines of our adaptive brains
- Addressing cognitive distortions (also known as "thinking errors")
- Catalyzing neurochemical changes in the brain

What Is a Feedback Loop?

Throughout this book, reference is made to a term we hear so frequently we seldom question what it means: *feedback loop*. As it turns out, this cultural volleyball of a term is extremely important for understanding how our minds work; so important, in fact, that I think a strong argument can be made that *feedback loops are the very engines of our adaptive brains*.

One of the bankable truisms of human nature is that beneath the surface of the raging sea of complexity we experience each day, we can find a few basic governing principles that explain a great deal of why we do what we do. For roughly forty years, research across disciplines

such as psychology, sociology, economics, engineering, epidemiology, and business strategy has exhaustively deconstructed and validated feedback loops as a solid governing principle with expansive explanatory power[3]. Once we get a good grasp on how they work, we'll be able to see that our brains house the most magnificent feedback loops on the planet.

Feedback loops operate in four distinct stages, each inextricably linked to the next[3]. We'll discuss each in more detail, but in short these stages are:

1. Evidence
2. Relevance
3. Consequence
4. Action

The Evidence Stage

Every feedback loop begins with data. In the broadest sense, data can be any information that's observed, collected, measured and stored—whether it comes from within you or without. Observing how coworkers interact at the office, seeing numbers displayed when you step on the scale, or homing in on that weird buzzing noise coming from your right front tire while driving are examples of ways we collect data.

The Relevance Stage

Here we move from data collection and storage to data input—but not data in its raw form. For data to become useful in the feedback loop, it must also be meaningful. Data that doesn't "click" is disregarded; it has to be relevant to the needs of the individual. For example, observing how your coworkers interact moves from raw data collection to meaningful data input when, perhaps, you sense that stronger integration with your peers will help you enjoy your time at work more than you do now, and maybe it will even help advance your career in the long run. That's the emotional "click" that keeps the loop moving.

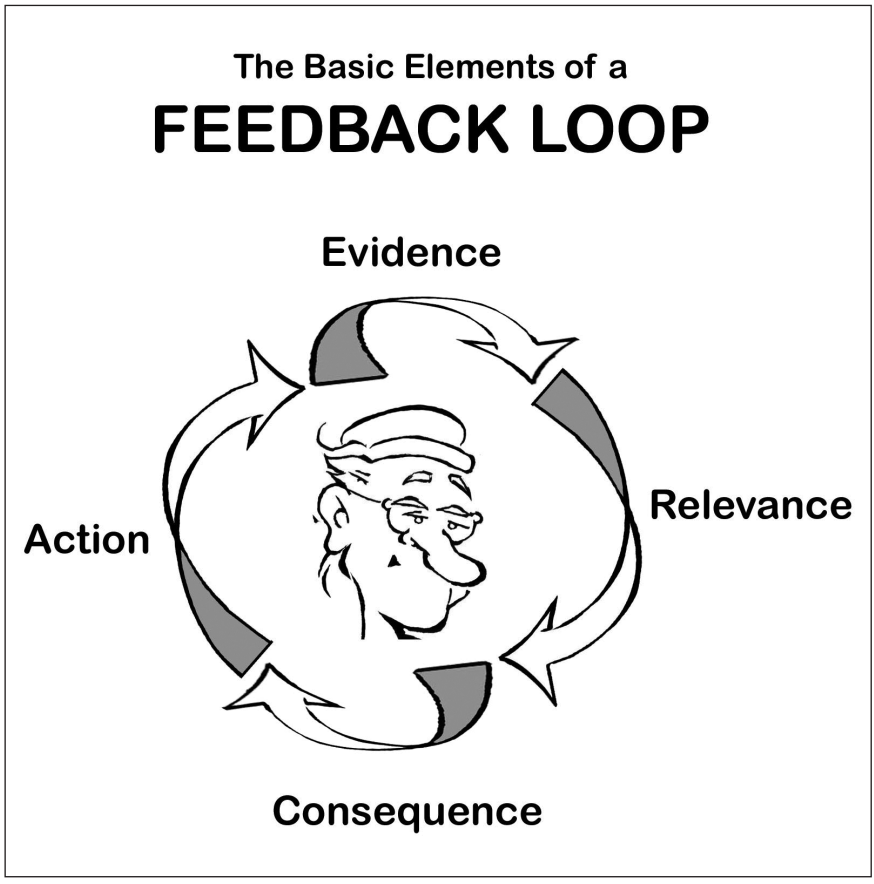


FIGURE 1.2

The Consequence Stage

Once we have meaningful data, the loop powers forward—but it won't continue unless we add another dimension: we have to know what to do with the information. You've made observations of how your coworkers interact, and you've identified an emotionally relevant reason why this information is meaningful. What's the consequence of possessing this information? Now you need to make a determination about the consequences of either doing something with the information, or doing nothing—which brings us to the final stage.

The Action Stage

When the requirements of relevance and consequence have been met, we are now faced with the challenge of doing. Continuing the office scenario: you've determined that failing to better integrate with this peer group will leave you floating uncomfortably at the periphery of the office social scene. As a consequence, you may miss out on networking opportunities that could benefit your career. Your path to action is illuminated. You move definitively ahead and take steps to improve connections with members of the group to accomplish your ultimate objective of becoming a regular and important part of it.

Once action is initiated, it's measured, and new observations are made—new evidence is collected and calibrated—and the feedback loop begins anew. With each rotation of the loop, you move closer to achieving your objectives.

Given this multistage explanation, it's easy to see why feedback loops are central to countless disciplines. Engineering, for example, relies on feedback loops to plan, design, develop and test everything from water-main pump stations to complex software applications. Business strategy relies on feedback loops to develop and launch business plans and marketing campaigns. Epidemiology relies on feedback loops to develop vaccines and new antiviral treatments. The list of examples is endless.

For our purposes, we're going to focus on what feedback loops mean in the cognitive context—we're going to remain focused on the brain. Equally important, we're going to focus on how feedback loops function as the brain's "engines." To put an even finer point on that: we're going to delve into how multiple feedback loops operating simultaneously and perpetually make our brain the incredible marvel that gets us through each day, moving us past obstacles, around threats, and ever forward toward our goals.

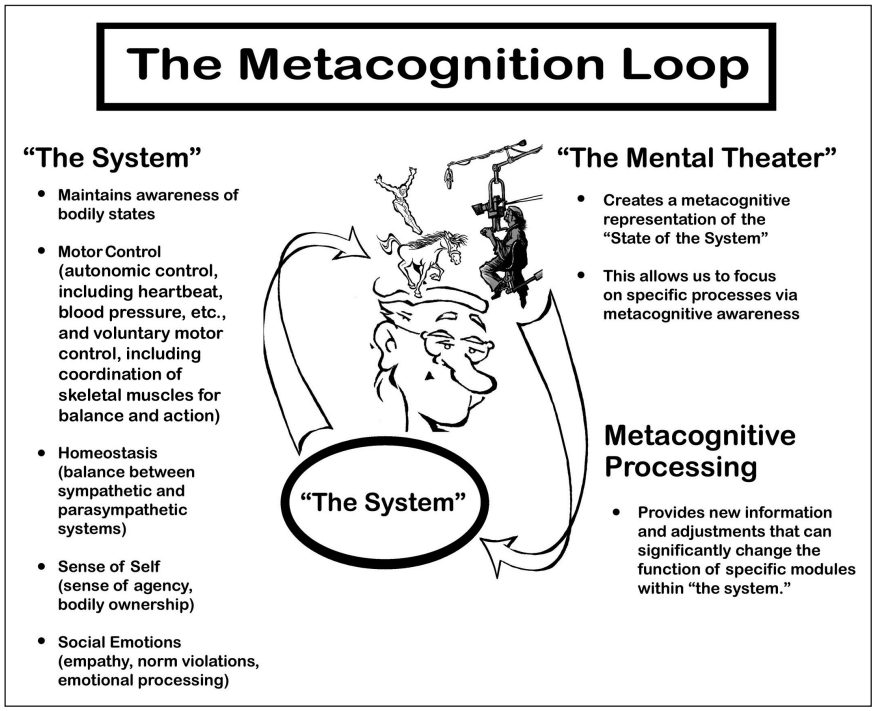


FIGURE 1.3

How the Human Brain "Does" Metacognition: The Metacognition Loop

Metacognition is not a mere theoretical concept—it is a function of our brains with vast neural underpinnings [4]. The brain structures that contribute to metacognition are not in any single place in the brain (as is true of most of our advanced cerebral abilities, such as memory). Rather, they communicate through neural connections in a mental network spanning multiple brain regions, particularly in the brain area known as the prefrontal cortex (PFC)—the most recently evolved part of the human brain, responsible for higher-order thinking and reasoning [5]. To simplify how the brain accomplishes metacognition,

it's useful to think of a feedback loop that incorporates both conscious and unconscious components of the mind.

The System

The loop begins at what I call "The System." This is where a great deal of unconscious processing occurs via what neuroscientists refer to as "modules." [6] Imagine for a moment trying to consciously control every movement of your right hand and arm, then your left leg, and then your head tilting to the right and so forth. Thankfully we don't have to "think" about these things on a routine basis: we can deliberately decide to make these movements, but we don't have to think about *how*. A motor-function-control module within The System operates such movements automatically without the need for direct conscious effort. Constant conscious monitoring and control of such movements—to keep your balance in gravity, for example—would be impossible, never mind the need to control vital functions and organs such as your blood pressure, your lungs, your heart, your nervous system, your digestion, and almost everything else happening in your body. They all happen unconsciously within The System, the most complex processing center on the planet. However, information from The System can reach conscious awareness. Some of this information arises automatically (hence the term "automatic thoughts"—thoughts that "pop" into consciousness), but with deliberate effort some information from The System can be moved to what I call "conscious mind space." And we can delve, to an extent, into the vast modular system to make adjustments.

The Mental Theater

To understand how information from The System reaches conscious mind space, it's useful to visualize this process as images being projected onto a screen. I call this screen "the mental theater." In the mental theater, our conscious processing abilities—principally residing in the prefrontal cortex—can focus on particular states of The System

(for instance, abstract modules such as social emotions or even physical modules such as blood pressure), which we may then deliberately choose to influence. In other words, information stored in The System can be retrieved or in a sense "checked out," like library books, for further inspection in the mental theater.[7]

Take, for example, certain social emotional responses you may have. Sometimes you may not understand why someone's actions strike you as, say, morally repugnant (you just "know" that they do). But if you project your emotional associations from the state of The System onto the screen of your conscious mental theater, you can take some time to figure out your reaction and perhaps come up with new insight into your thinking. Maybe you realize, for example, that the root of your moral outrage is a hazy memory of similar actions by someone in your past. Perhaps this person reminds you of a cousin who bullied you many years ago. This realization is then looped back into The System, and in this example, back into the module regulating your sense of social emotion. So the next time you encounter this person, he or she won't automatically trigger your moral indignation.[8]

At a more basic level, we can influence tangible dynamics like blood pressure through the metacognitive loop. Once we have a state of The System such as blood pressure in the theater of our mind (brought to the theater, in this case, via a feedback technology such as a blood pressure monitor, the inflatable arm cuff we're all quite familiar with), we can use any number of consciously controlled means to affect it—meditation, perhaps, or other forms of relaxation techniques. Even choosing to take medication to control your blood pressure is the result of conscious assessment. In that case, it isn't only an adjustment to thinking that's looping back into the system, but also a chemical agent that will influence the System module controlling your blood pressure.

Whether a module is emotional or physical, conscious influence is only possible through metacognitive processing—or a *conscious detachment* (which we'll discuss shortly) from whatever it is we're interested in assessing and possibly changing.

Metacognition in the Consciousness Context

OK, we've focused on the feedback loop that spans the reaches of the unconscious System and the conscious mental theater. But now we have to step back and take a wider view, because focusing *only* on the loop does not tell us the complete story of metacognition. We now have to address an exceptionally challenging problem in neuroscience—how metacognition operates within the greater context of consciousness. To work through this problem, we'll begin with a new graphic.

Back in the day, Freudians would have said that the unconscious was a seething cauldron of unfelt emotions, and the purpose of psychoanalysis was to venture with a guide into this mysterious, frightening

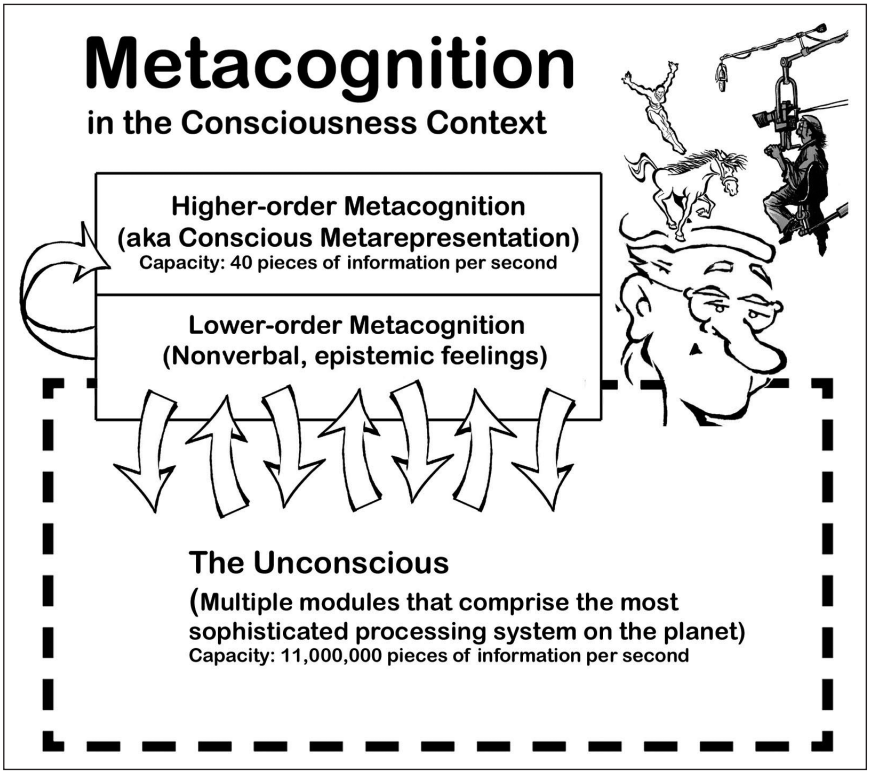


FIGURE 1.4

space and track those feelings to their primal sources in childhood desires and fantasies. Today, cognitive scientists speak of the "New Unconscious" to differentiate their concept from the Freudian notion of the unconscious [9]. The new unconscious isn't free from the chaos of unfelt emotions, unmet needs, wants, and desires—but what we now understand, after more than a half a century of intense research, is that the unconscious is more akin to a massive modular processing system than to a psycho-emotional abyss. The best estimates of this system's power are that it handles roughly 11 million pieces of information per second [10].

In contrast, the best estimate for how much information our conscious mind space can handle is about 40 pieces per second [11]. If we broke out the consciousness picture into percentages, conscious mind space would account for about one percent of the brain's processing mojo; the rest resides in the "new unconscious"—a modular and unfathomably powerful mega machine.

This is where the discussion gets tricky. It's tempting to believe that we can directly access and change what's happening in the unconscious. But this is largely a misperception known as the "introspection illusion." [12] Introspection—literally "looking into oneself"—is not a waste of time, but it's also not a magical key to unlocking the unconscious. Unfortunately, many self-help and new-age books would have us believe that introspection is such a key, and that learning new (or ancient) methods of introspecting will get us what we want from our unconscious minds, as if on tap.

From a science-help perspective, we have to take a more grounded view of what we can and cannot accomplish via introspection or any other inwardly focused techniques. Access to the unconscious is possible, but it is limited, and that's not a bad thing. Evolution has installed a system of inestimable value in our brains called "automaticity," which allows all of those unconscious modules we've been referring to (those and thousands more) to run without conscious intervention. Most of the thoughts and feelings we experience from our unconscious are non-verbal and "epistemic"—they're not quite tangible, but they're also not entirely abstract. These include the

feelings of knowing and of forgetting; the feelings of confidence and of uncertainty; and the "tip-of-the-tongue" phenomenon (e.g., "I know the name of that rock band but it's not coming to me—but I know I know it!").

Epistemic thoughts and feelings percolate from the unconscious into a space known as *lower-order metacognition* (*see the lower section of the metacognition box in figure xx*). In this space, we begin grappling with unconscious unknowns, but they aren't yet in the theater of the mind. That doesn't happen until the command and control center—our prefrontal cortex—loops them into *higher-order metacognition* (also called *conscious metarepresentation*—the upper part of the metacognition box in the graphic). This is the part of our mind where a certain conscious clarity asserts itself – where we can mentally detach and *see* what we're thinking and feeling.

As noted, we can handle about 40 pieces of information per second in this conscious mind space. That's a sliver of what our unconscious is handling, but it's not an inconsequential amount of processing power. We can accomplish quite a lot at 40 pieces a second—and the better we become at using metacognition to our advantage, the more efficient we become at leveraging this processing power. We are, in effect, training our brains to run the metacognition loop more often and more efficiently—*and that is the essence of our brains' adaptive ability*.

Metacognitive Awareness

With the basics of metacognition laid out, let's now talk about something psychologists refer to as "metacognitive awareness" and how it fits into our exploration thus far. Psychologists use a questionnaire ranking system to determine a person's level of metacognitive awareness – *how aware we are that we're actively examining and influencing our thinking*. The more metacognitvely aware you are, the less you use autopilot to guide your thinking processes [13].

Another way to think of metacognitive awareness is as the conscious act of coming up with strategies that select among available cognitive (thinking) responses. One researcher compared metacognitive

awareness to a volume control: the higher we can raise the metacognitive volume, the more aware we are of possible thinking responses Again, we formulate these thinking strategies in the theater of the mind—so to continue the metaphor, we're not only turning up the volume, but also the screen resolution.

Metacognitive awareness comprises four main factors [13]:

- **Metacognitive control:** The amount of conscious control we exert over our thoughts and feelings in conscious mind space.
- **Metacognitive knowledge:** The quantity and quality of knowledge we're looping into conscious mind space.
- **Metacognitive monitoring:** The frequency and efficiency with which we are evaluating knowledge in conscious mind space.
- **Metacognitive experience:** What we learn from the knowledge in conscious mind space, and how this experience enables us to get even better at the entire process.

As we learn to boost our metacognitive awareness and use it to our advantage, we gain greater influence in our brain's feedback loops. We become increasingly more self-aware about how our experiences—internal and external—influence our brains, and we find open doors to tweak those influences and, thus, change how our brains respond.

Said another way: the better we become at thinking about our thinking, the better we become at adapting to change and choosing directions that achieve better outcomes in our lives.

A Practical Metaphor: The Journalist Inside

My metaphor of choice for metacognition is that of the journalist, because a good journalist embodies the main characteristics of someone skilled at getting the most out of metacognitive awareness:

A good journalist…

- Acts quickly
- Relies on solid sources

- Asks the right questions
- Follows the story where it leads
- Doesn't gloss over inconvenient facts

(In *Part II: DO*, you'll be introduced to several other metaphors of mind—what I call "The 12 Metarepresentations of Mind"—but for now we're going to stay with the journalist because it's an especially useful metaphor for metacognitive awareness.)

Here's how each of the journalist's characteristics match up with metacognitive awareness.

Act quickly.

Journalists seldom have the luxury of wasting time when making determinations about how to tackle a story. To stay timely, they have to act fast. So too must metacognitive awareness be engaged quickly to make a difference. We have to be ready to detach and assess a situation on the spot, because the dynamics of whatever is going on are probably moving too fast for anything but immediate action.

Rely on solid sources.

Knowledge is a tool, just as logic and instinct are tools. While we can't rely on it solely (just as we cannot rely on logic or instinct solely), not making the best use of knowledge is a prescription for mediocrity, if not outright failure. My argument throughout this book is that finding and applying knowledge clues from solid sources gives us a metacognitive edge.

The sources referenced and recommended throughout this book are primarily research-based and come from a range of disciplines. A good journalist digs deep and embraces an interdisciplinary approach, because any single discipline may not offer enough information. The

journalist makes it his or her mission to break down the traditional silos that too often prevent disciplines from mutually benefiting—the journalist is an interdisciplinary synthesizer of knowledge. So, too, should we rely on a breadth of sources to enhance our metacognitive awareness. Finding and digesting these sources is an ongoing learning process, one that will benefit us greatly if we make it a regular part of our routines.

Ask the right questions.

A good journalist drives to the point with incisive questions, instead of meandering around the substance of the matter with softball questions. The same is true for making best use of metacognitive awareness. We don't do ourselves any favors when we dodge and hedge instead of getting right to the core of what's going on. In addition, we don't have time for fluff; remember that time is usually not on your side in this process, so moving decisively ahead is imperative.

Follow the story where it leads.

Journalists are detectives with a penchant for expression. When they ask the right questions, the story may shift and turn, and it's their job to follow it. But they also have a sense of when not to follow, if they think they're being led down a rabbit hole. The metacognitive corollary is that there's a lot going on in your mind at any given moment. Some of it is relevant to the questions you're asking yourself, some is not. You have to train yourself to sniff out relevance and follow it if you think it will help. Anything with the odor of distraction must be disregarded.

Don't gloss over inconvenient facts.

Finally, a good journalist in possession of the facts doesn't censor out that which is inconvenient or potentially offensive. If these are the facts that matter, then they're part of the story. With metacognition

you have to be willing to acknowledge everything you find, no matter how painful or embarrassing. Your internal search, like the journalist's search, has been undertaken in earnest to get to the truth, and that truth may not be pretty. That's something we all have to come to terms with.

Now, you may be asking, "Exactly how am I supposed to move through those steps if there's so little time?" The answer is that while they seem like steps, they're actually all part of a single discipline. Journalists embody each of those attributes and act on them in tandem. It's the same with metacognitive awareness. Every time we consciously engage metacognitive awareness, we don't deliberately move from point A to B to C; like a seasoned journalist, we train ourselves to do it all simultaneously.

Chapter Wrap-Up

We've discussed what metacognition is and the role it plays in our thinking; what a feedback loop is and why it's an essential concept when we're discussing the brain and mind; and how the discipline of a good journalist matches well with metacognitive awareness.

Here's a collection of Big Picture Takeaways for Chapter 1:

- Metacognition means "thinking about thinking."
- Feedback loops comprise four main elements: evidence, relevance, consequence, and action.
- The Metacognition Loop is the process by which unconscious information (in "The System") is looped into conscious mind space (the "mental theater") and changes to that information are ultimately looped back into The System. However, we must resist the notion that we can gain on-demand access to the unconscious through introspection; believing we can do so is called the "introspection illusion."
- We can gain a limited amount of access to the unconscious via the metacognitive loop—but it's useful to keep in mind that this process includes two levels of metacognition: lower-order

(where we receive epistemic thoughts and feelings) and higher-order (where we can *see* with a detached sense of conscious clarity what we think and feel).

- Metacognitive awareness is the degree to which we use metacognition to select from "thinking strategies" that in turn influence our thoughts and behavior.
- The disciplines embodied by a good journalist line up well with the disciplines required to use our metacognitive awareness to our greatest advantage.
- The "process steps" a journalist uses are actually not steps at all, but a continuum of thinking and action; the same goes for metacognition.
- Training ourselves to expand and improve metacognitive awareness takes effort, but doing so will improve our chances of reaching the best possible thinking outcomes.

Thanks for checking out a preview of

BRAIN CHANGER

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